State Facility Water Use and Conservation Survey

Final Report

Angela Burnett Penn
Brandeis University, Intern – Water Policy and State Sustainability Programs
Executive Office of Environmental Affairs
April, 2007

Introduction

Massachusetts has traditionally been endowed with ample freshwater resources. As the State has prospered and the population grown, however, this freshwater resource base has come under significant stress in many areas. The future growth and prosperity of Massachusetts depends on a sustainable freshwater supply, and thus the water resources of the State must be wisely managed.

Water conservation is an important element of a wise water resource management policy and is, thus, a priority area for the State. Water conservation refers to any effort to reduce the use, wastage, or loss of water. Water conservation helps to ensure a sustainable water supply, helps to protect animal habitats, and can result in real cost savings both through lower water bills and reduced energy needs for hot water.

Recognizing the benefits of water conservation, the Executive Office of Energy and Environmental Affairs (EOEEA), together with the Water Resources Commission produced the updated *Water Conservation Standards* for the Commonwealth of Massachusetts in July, 2006. The 2006 Standards set new water conservation goals for the State and give a set of standards and recommended actions for water suppliers and water users in order to meet the established water conservation goals.

During April 2007 a representative subset of Massachusetts State facilities participated in a Water Use and Conservation Survey, a joint effort of the State Sustainability and Water Policy Programs of EOEEA. A total of 20 facilities participated in the Survey. The sample group was

comprised of State colleges/universities (9), health facilities (3), correctional facilities (4), and standard office buildings (4). Participating facilities represented the larger sized facilities in their respective categories and were selected to provide diversity with respect to location (urban versus suburban), watershed characteristics (stressed versus unstressed), facility usage (residential versus non-residential), and water usage (suspected heavy indoor versus heavy outdoor usage in particular). A list of facilities that participated in the Survey is provided in Appendix I.

The purpose of the Survey was to gather basic information that would better inform the implementation of the 2006 Water Conservation Standards (http://www.mass.gov/envir/mwrc/pdf/Conservation_Standards.pdf). The Survey was administered through a questionnaire (see Appendix II) that included 5 main sections as follows: Background Information, Water Supply and Disposal, Leak Detection and Metering, Water Use and Water Fixtures, and Water Conservation Practices.

The Background information section asked for basic information that would likely be correlated with the amount of water a facility is using (such as the average daily population that uses the facility). The Water Supply and Disposal section determined where facilities are obtaining their water supply and what happens to wastewater generated by the facility (including if there is any on-site re-use of wastewater e.g. for lawn maintenance).

The Leak Detection and Metering section established if facilities are doing simple preventative checks to make sure they are not losing large volumes of water over time through leaky water fixtures. An important question in this section was whether or not a facility has ever conducted a comprehensive water audit. Doing regular water audits is one of the recommendations in the 2006 Water Conservation Standards. In the case of a particular facility, a comprehensive water audit compares the amount of water entering a facility's perimeter, the amount of water actually consumed by the facility, and the amount of water leaving the facility and sent to a centralized wastewater treatment facility, for example. A water audit also includes a walk through of the facility to check the water distribution pipes and water fixtures for leaks. A water audit is highly beneficial to facilities and is an important step in planning for water conservation because it allows the facility to determine if and where it is losing water and which specific areas of the facility need the most improvement. In order for a facility to undertake a comprehensive water audit it needs to have a water metering system that allows it to monitor separately the amount of water entering the facility's perimeter, the amount of water consumed by different buildings/building clusters, and the amount of water leaving the facility. The Leak Detection and Metering section, therefore, also established the prevalence and distribution of water meters at facilities.

The Water Use and Water Fixtures section asked facilities to report how much water they consume annually and how that usage is distributed (i.e. indoor versus outdoor water use and different types of indoor water uses). This section also asked for a detailed breakdown of the types of water fixtures (standard versus water saving) used at the facility. The Water Conservation Practices section was meant to determine the facilities' level of interest in water

conservation initiates and to determine the prevalence of outdoor water conservation practices and water conservation education at State facilities.

This Report presents the major findings of the Water Use and Conservation Survey as well as recommendations for increasing water conservation at State facilities.

Major Findings of the Water Use and Conservation Survey

This section presents the major findings of the Water Use and Conservation Survey. The findings are organized according to the main sections of the questionnaire used to administer the Survey: Water Supply and Disposal, Leak Detection and Metering, Water Use and Water Fixtures, and Water Conservation Practices.

Graphs are often used to represent the Survey findings in a highly visual format. It should be noted that due to quantitative data gaps, not all facilities are represented in each graph; where appropriate, additional qualitative information is injected in-text. Also note that the findings presented here are not comprehensive; for the sake of a consolidated report, many interesting facility by facility details have been omitted.

Water Supply and Disposal

Most (55%) of the facilities surveyed get their freshwater from a public water supplier other than the Massachusetts Water Resources Authority (MWRA), typically the relevant town public supplier. A significant (30%) of participants, however, use the MWRA as their supplier (this category was dominated by the State office buildings in Boston). The use of a private/on-site supply (whether wholly or partially) only occurred where a facility needs extra water for outdoor purposes or their location is such that it was not practical to connect to the town supply. Private/on-site supply is limited to the remaining 15% of facilities (see figure 1).

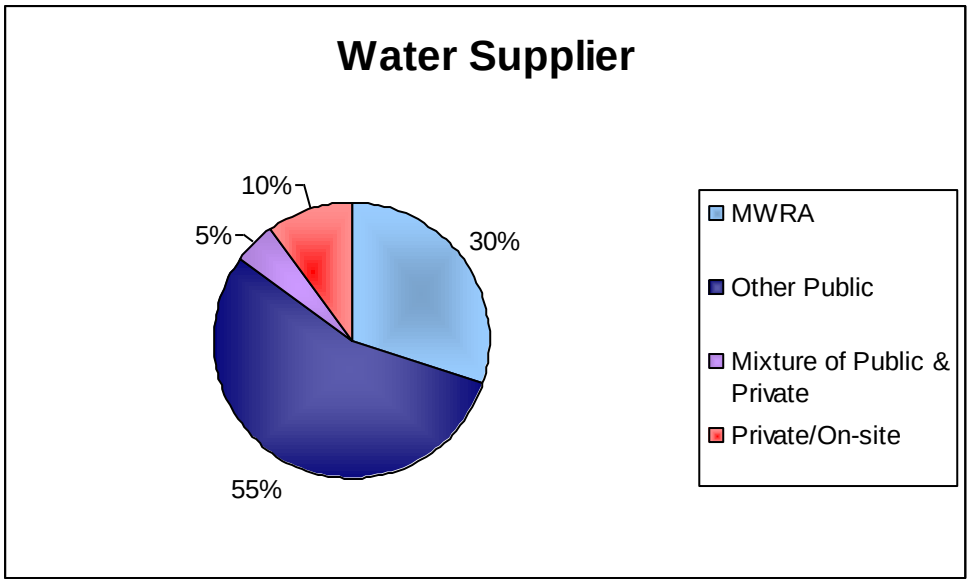

Figure 1. Source of water supply for 20 Massachusetts State facilities.

In terms of wastewater disposal, almost all facilities (90%) are connected to the municipal sewerage system, and thus send their wastewater to a centralized wastewater treatment facility (see figure 2). Depending on where such facilities and their effluent outfalls are located, centralized wastewater treatment facilities can negatively impact watersheds by effectively extracting freshwater from a particular watershed and either pumping it offshore or recharging it in another watershed. A more watershed friendly approach to wastewater treatment is on-site treatment and effluent recharge. Under this approach, water extracted from the watershed is ultimately returned to the watershed and recycled. Only two facilities (both of which were correctional facilities) utilized this method for wastewater treatment as alternatives were unfeasible.

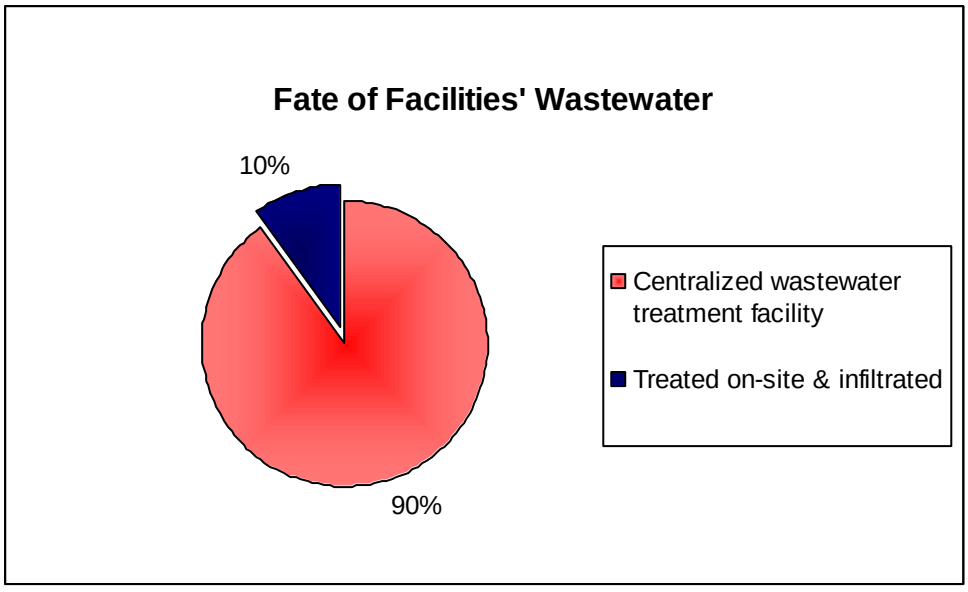

Figure 2. Fate of wastewater generated by 20 Massachusetts State facilities.

Re-use of storm water or use of collected rain water for outdoor watering purposes such as lawn maintenance, landscaping, building or vehicle washing is extremely limited. Of all 20 facilities surveyed, there was only one example of this kind of effort. Quinsigamond Community College uses a simple rain water collection system to meet all of its landscaping needs. In 2005 Quinsigamond invested in an $80 rain barrel (see figure 3) to collect rainwater from the roofs of campus buildings. The collected water is used to water small planters around the campus.

Figure 3. Example of a rain barrel

Leak Detection and Metering

Metering water use is a fundamental aspect of water conservation; without metering facilities do not have a good sense of how much water they are consuming or how and where water is being used. A high percentage (95%) of facilities surveyed meter their water usage. Of the 11 metering facilities that have both indoor and outdoor water usages, 64% (6 facilities) meter both indoor and outdoor water use (whether separately or combined). Of all 19 metering facilities, most (11) facilities only have one meter for the entire facility (4 of these facilities were singular office buildings). The remaining 9 facilities have multiple meters that are able to capture water usage as either building/building cluster consumption (6) or indoor versus outdoor consumption in addition to building/building cluster consumption (3).

The frequency of monitoring water fixtures for leaks varied greatly by facility and was highly dependent on the type of water fixture. Highly visible or regularly used fixtures such as toilets, faucets, and shower heads are checked for leaks most frequently (on a daily or routine basis in most facilities). Water fixtures that are more difficult to access or that are used only seasonally are never checked in most facilities or are checked on only an annual basis (see figure 4).

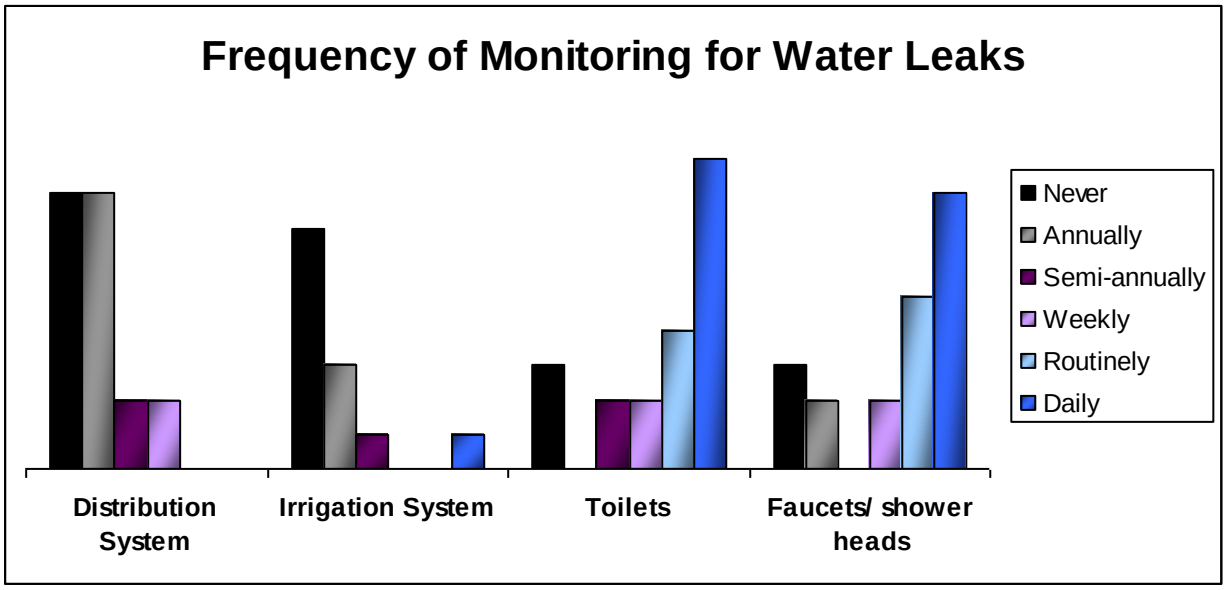

Figure 4. Schedule of checking water fixtures for leaks at 20 Massachusetts State facilities.

The majority of facilities surveyed (68%) have undertaken a comprehensive water audit (figure 5). Most of these water audits were conducted fairly recently (as of 2000), but a couple were undertaken in the mid 1990s. While most facilities have only undertaken one comprehensive water audit, water audits are an integral part of maintenance at a few. Bridgewater State College, for example, has been conducting yearly in-house water audits since 1984. Those facilities that have undertaken a comprehensive water audit have found them to be extremely helpful in not only planning for water conservation, but detecting problems early and thus saving money.

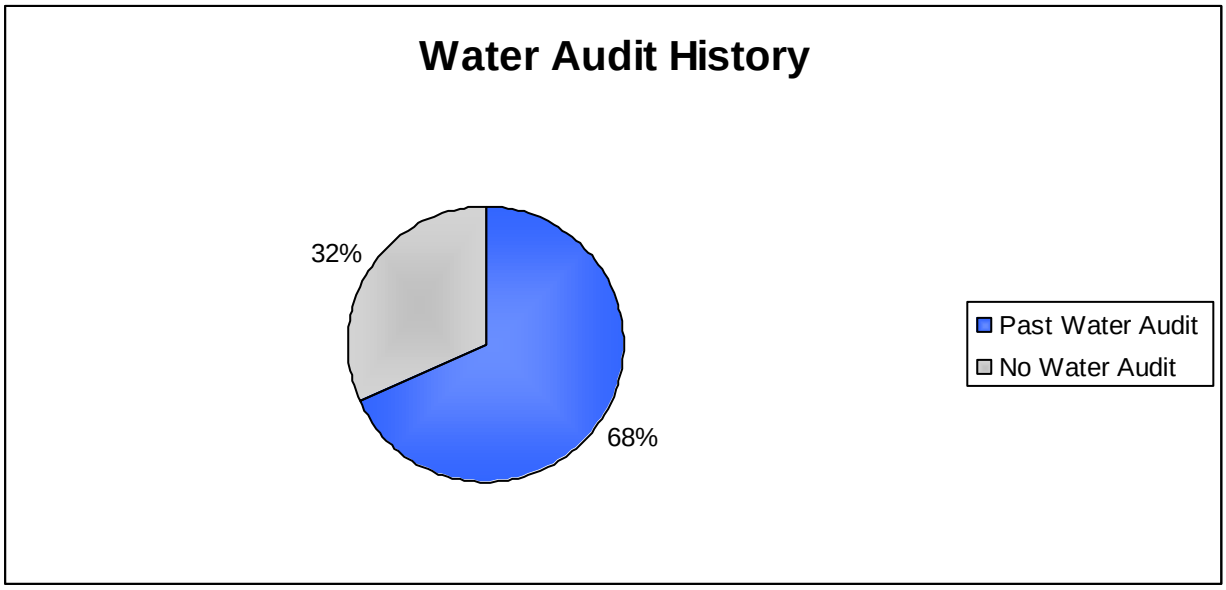

Figure 5. History of a comprehensive water audit at 20 Massachusetts State facilities.

Because monitoring of fundamental water fixtures (especially distribution pipes) is not nearly as frequent as should be, because a large percentage of facilities have yet to undergo a comprehensive water audit, and because metering at many facilities remains just mass metering, a significant portion (35%) of facilities were unsure if they were having problems with unaccounted for water (UAW). In terms of a single facility, UAW exists if there is a difference between the total amount of water supplied to the facility (as measured by a master meter) and the sum of all water actually used by the facility (as measured by consumption meters in the facility distribution system).

Of the 13 facilities that could report on UAW, 11 (55% of the total) reported no problems with UAW and the remaining two (10% of the total) reported problems with UAW (figure 6).

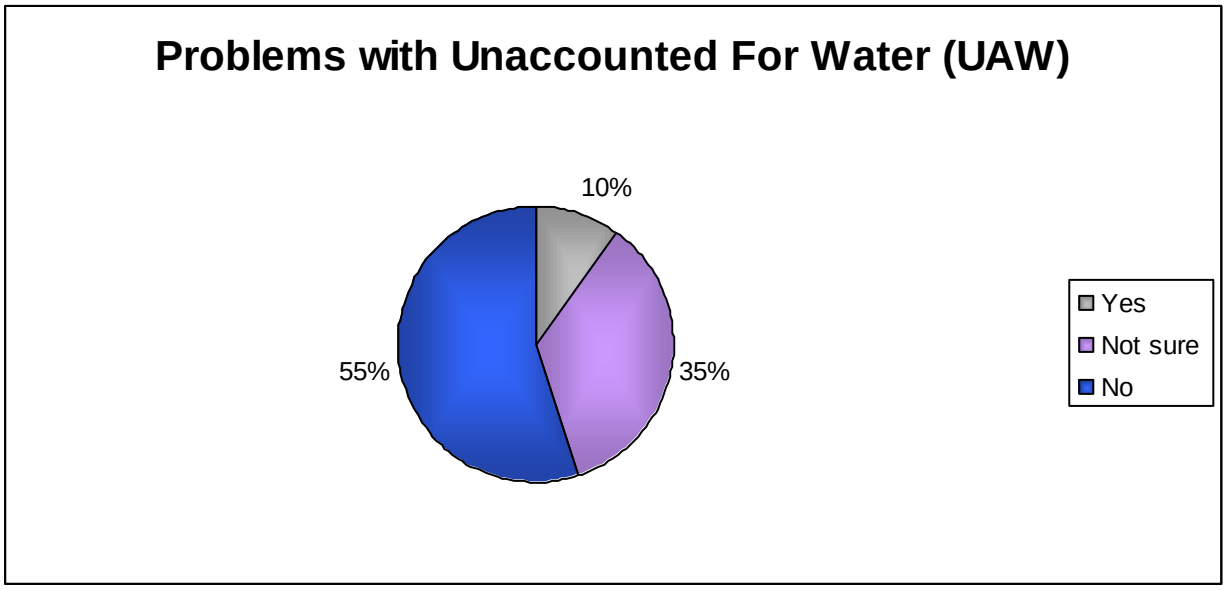

Figure 6. Knowledge of problems with Unaccounted for Water (UAW) at 20 Massachusetts State facilities.

Water Use and Water Fixtures

Of the facility types surveyed, State colleges/universities and State correctional facilities are clearly consuming the most water annually. All facilities that use between 30 million and 100 million gallons of water annually are either State colleges/universities or State correctional facilities. UMass Amherst stands out as the biggest water consumer among all the facilities surveyed, using some 286 million gallons of water annually (more than 3 times the water consumed at any other facility). Facilities consuming between 5 and 15 million gallons of water annually included all State office buildings as well as Umass Darmouth, a mid-sized residential college. Facilities consuming less than 5 million gallons of water annually included all State

health facilities and four (4) State colleges without an in-residence population (see figures 7 & 8).

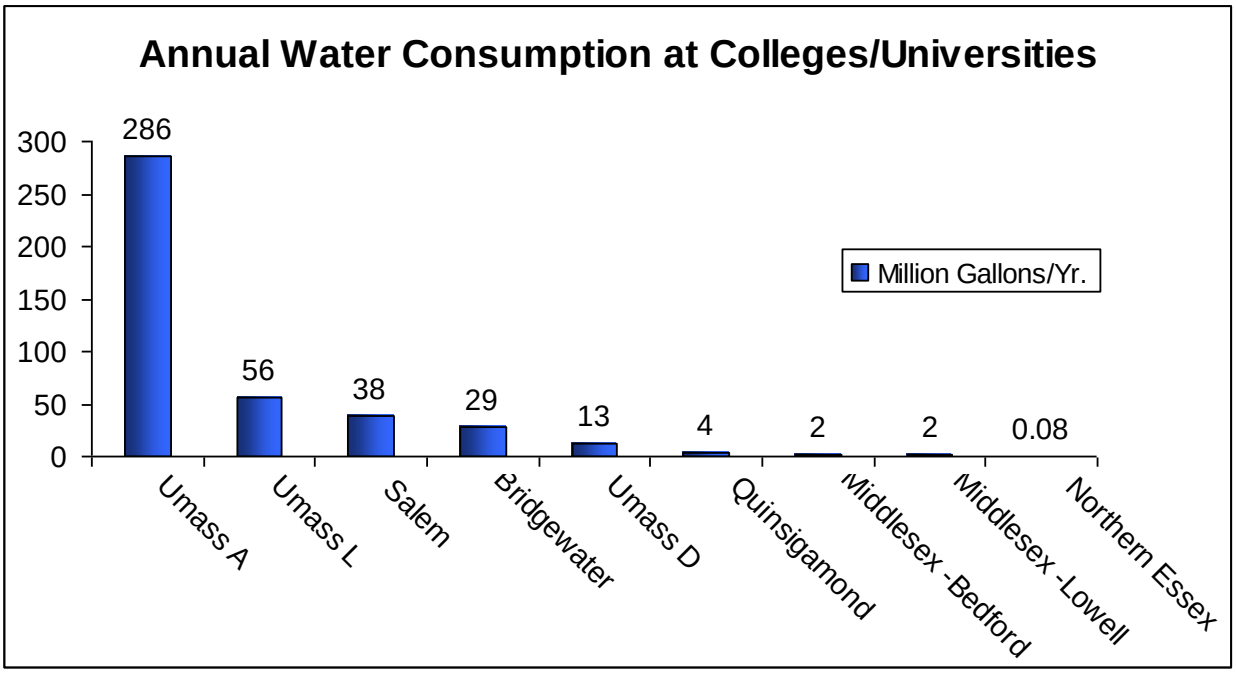

Figure 7. Annual water consumption at 9 Massachusetts State Colleges/Universities

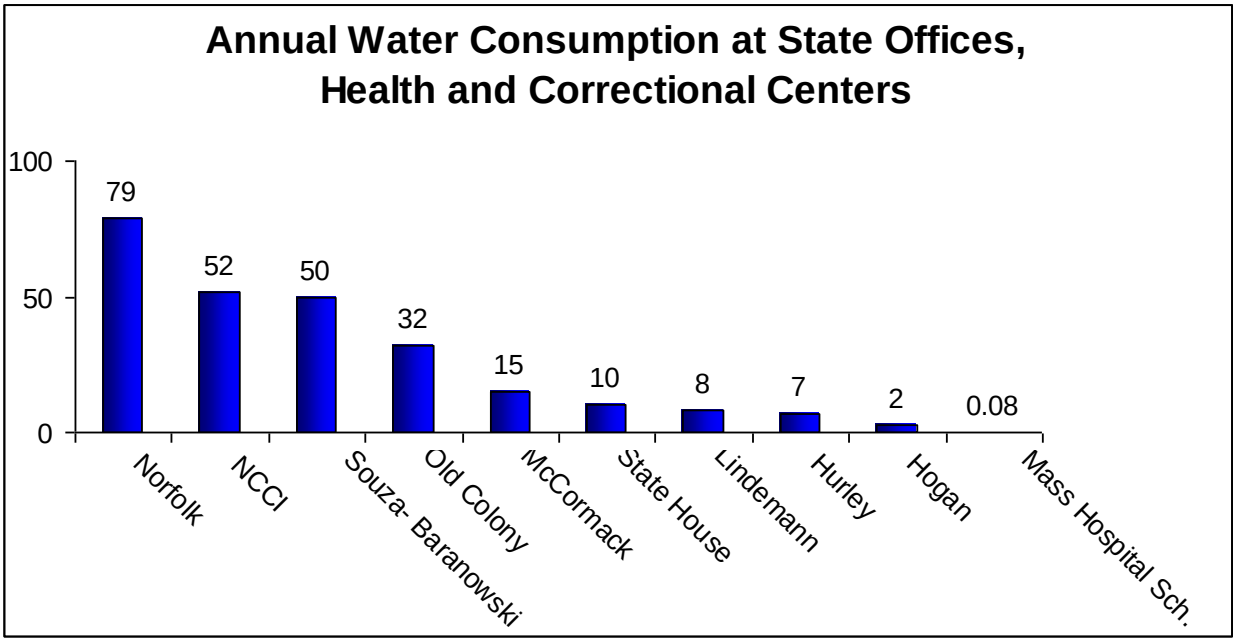

Figure 8. Annual water consumption at 10 Massachusetts State offices, health and correctional centers.

Across all facility types, sizes, and locations, outdoor water use typically accounts for a very limited portion of total water use at state facilities (figures 9 and 10). Most facilities report outdoor water use as only 5% or less of total water use (figures 9 and 10). Only one facility (Middlesex Community College – Bedford) reported outdoor water use a major contributor to total water use (30% of total water use) as result of inefficient irrigation methods. The finding of low outdoor water use is not just incidental; a very positive finding of the Water Use and Conservation Survey is that the clear majority of State facilities are strictly limiting outdoor water use, including big college campuses with lots of lawn area. For example, UMass Dartmouth, Bridgewater State College, and Quinsigamond Community College all report no outdoor water use. The trend towards limited outdoor water use is also visible in figure 11.

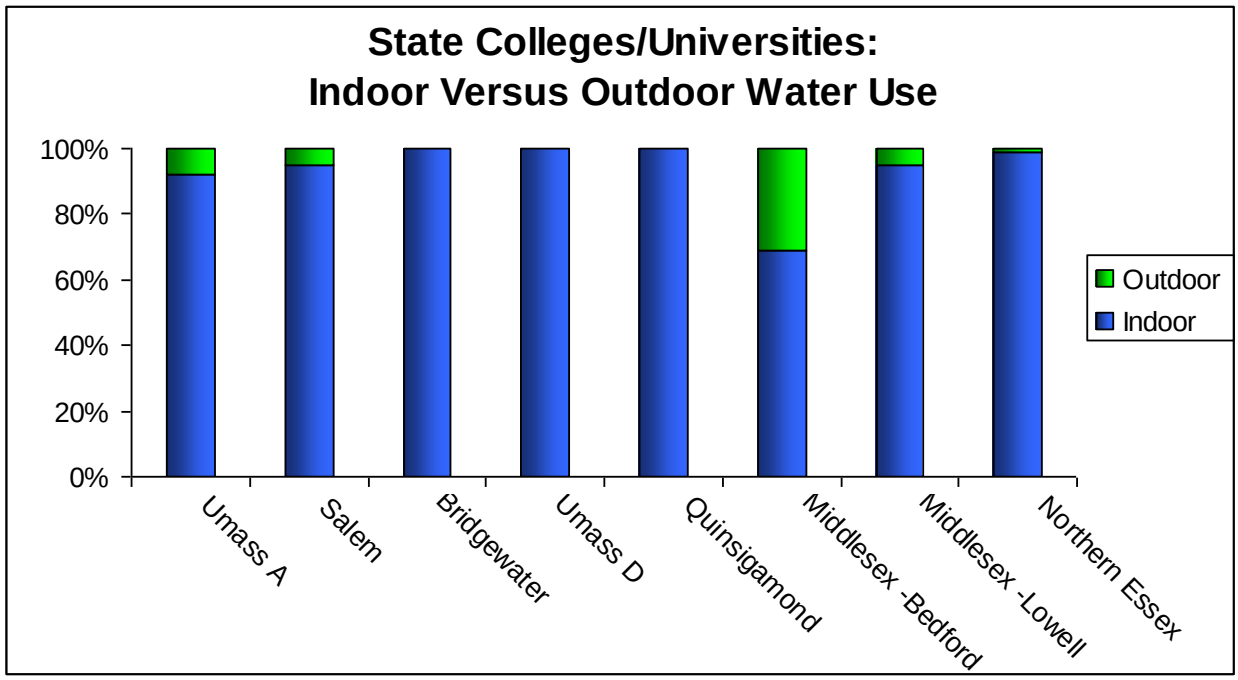

Figure 9. Breakdown of water use (indoor versus outdoor) at eight Massachusetts State colleges/universities.

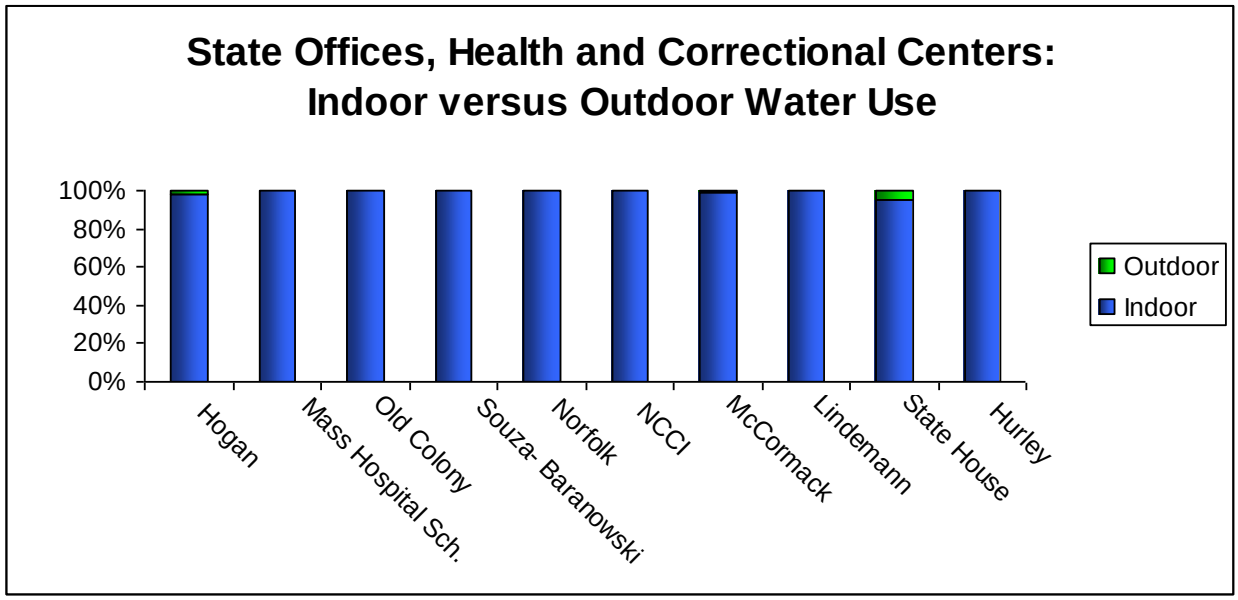

Figure 10. Breakdown of water use (indoor versus outdoor) at 10 Massachusetts State offices, health and correctional centers.

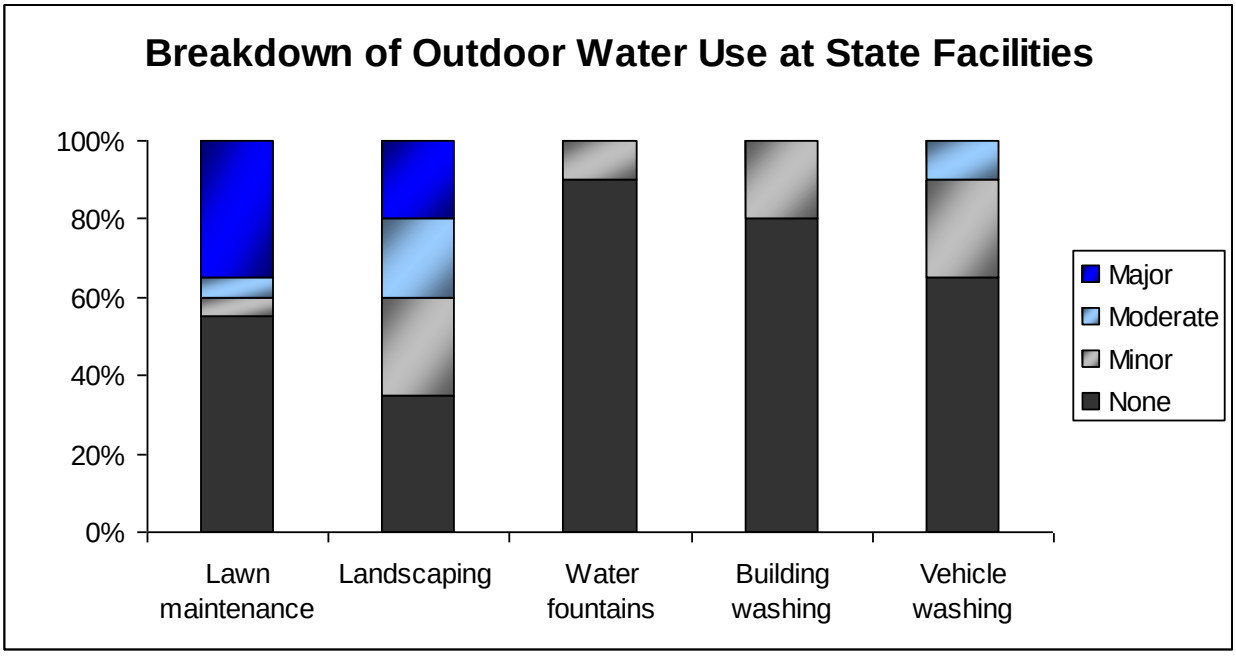

Figure 11. Breakdown of outdoor water use at 20 Massachusetts State facilities.

As the majority of water use is indoors, it is important to understand more precisely how that water is being used. Facilities were asked to rate a list of indoor water uses as either minor (<10% of indoor water use), moderate (10-30%), or major (>30%) (see figure 12 for results). From the graph it is clear that the "major" indoor water uses are flushing toilets and washing hands etcetera at faucets. The "moderate" indoor water uses include showering, laundering, and cooking. The "minor" indoor water uses include running cooling and heating systems, cleaning, laboratory work, and pool maintenance. It should be noted that while heating systems are overall a "minor" consumer of indoor water, at some facilities (for example UMass Amherst) heating systems can be major contributors to total indoor water use; this is typically the fault of inefficient heating systems).

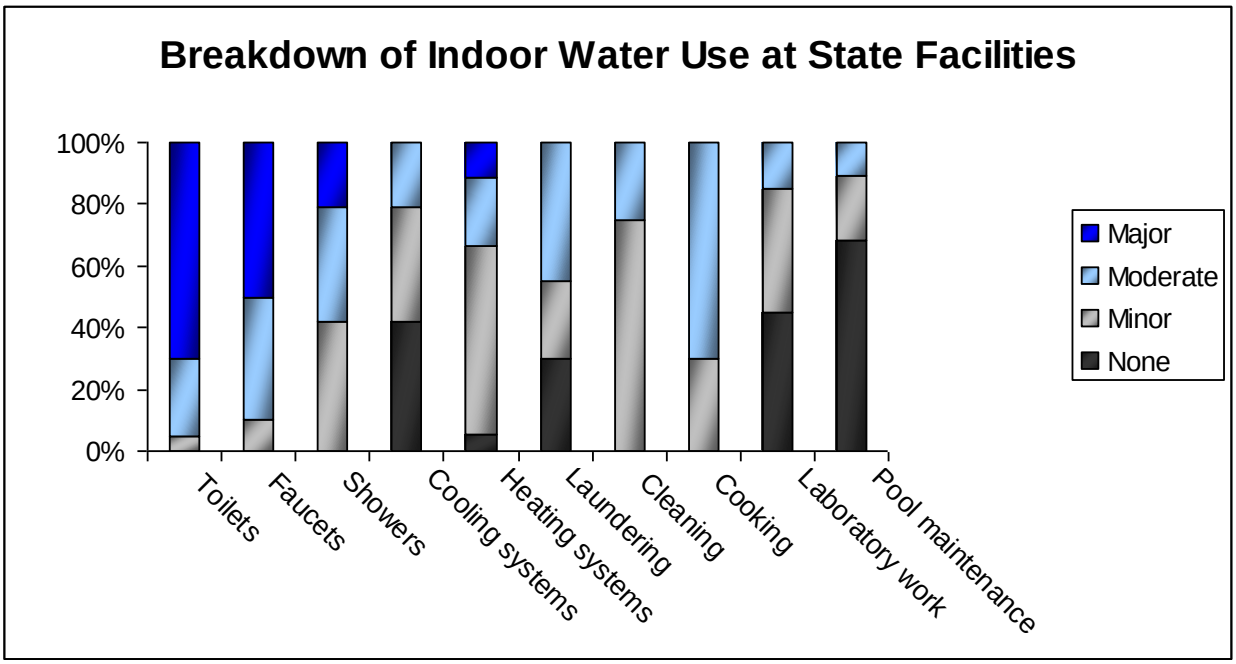

Figure 12. Breakdown of indoor water use at State facilities.

The design of common water fixtures including toilets, faucets, showers, and washing machines have a major impact on indoor water consumption; water saving designs can cut water use by 50% or more. Figure 13 gives an overview of the stock of water fixtures at the 20 State facilities surveyed. Figures 14-17 give a more in depth look at the stock for each specific water fixture.

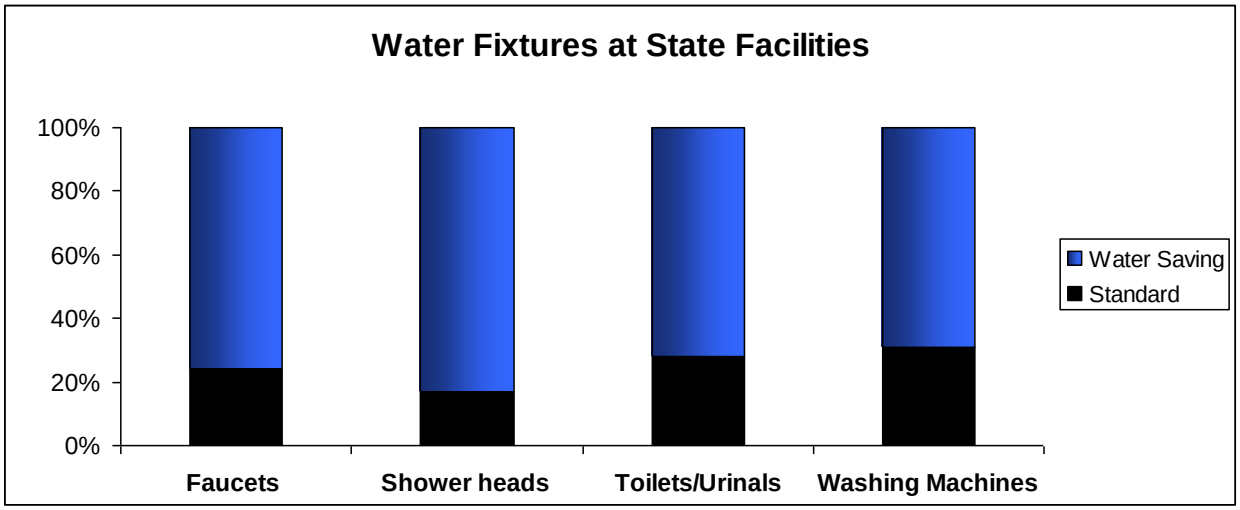

Figure 13. Prevalence of water saving design fixtures in 20 Massachusetts State facilities.

The results in figure 13 show that the prevalence of all water saving devices is equally high. Roughly 80% of standard toilets, faucets, showers, and washing machines have been replaced with water saving designs. While this result is certainly very positive, there is still a lot of room for improvement. As figures 14-17 highlight, the replacement of fixtures as been highly polarized with some facilities replacing 100% of all fixture types and some facilities replacing none of their standard fixtures. A review of graphs 14-17 gives an indication of those facilities that have been doing a good job on water fixture replacement and those facilities with lots of room for improvement. This list is by no means comprehensive, but in particular, Bridgewater State College, Salem State College, and the Souza- Baranowski Correctional Center stand out for having basically 100% water saving fixtures. Again, not a comprehensive list, but some facilities that stand out with significant room for improvement include Northern Essex Community College, NCCI/Gardner Correctional Center, and Massachusetts Hospital School. Not included in the graphs for lack of quantitative data, but an important facility to mention in need of improvement is UMass Dartmouth.

The water saving designs most popular among facilities include aerated faucets, low flow shower heads, ultra low flush toilets, 1 gallon/flush urinals, and front loader washing machines. There were very few to no cases of waterless urinals, dual flush toilets, and composting toilets in particular.

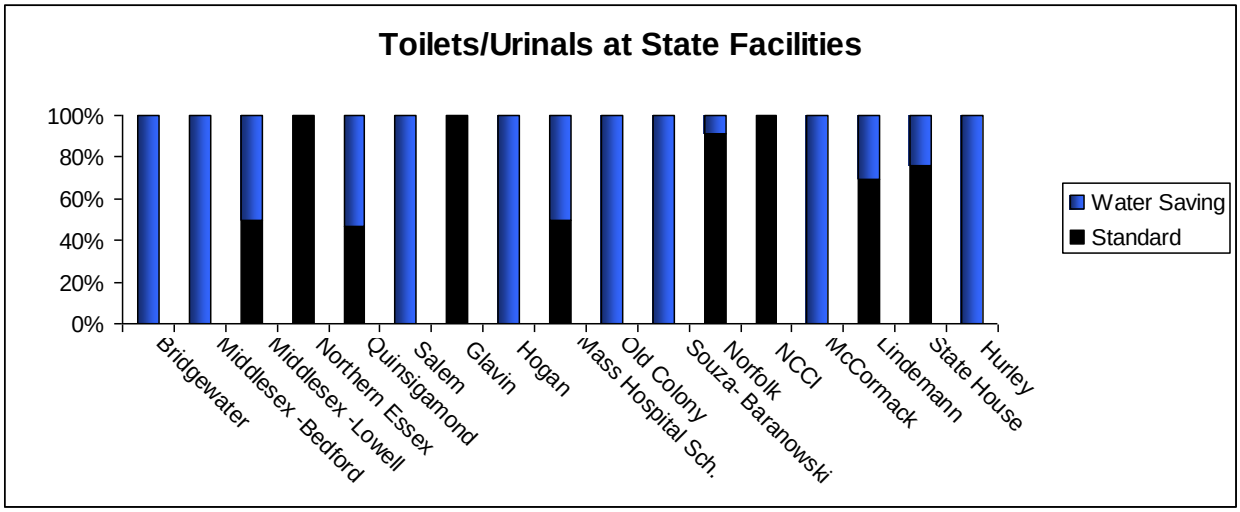

Figure 14. Prevalence of water saving toilets/urinals at Massachusetts State facilities.

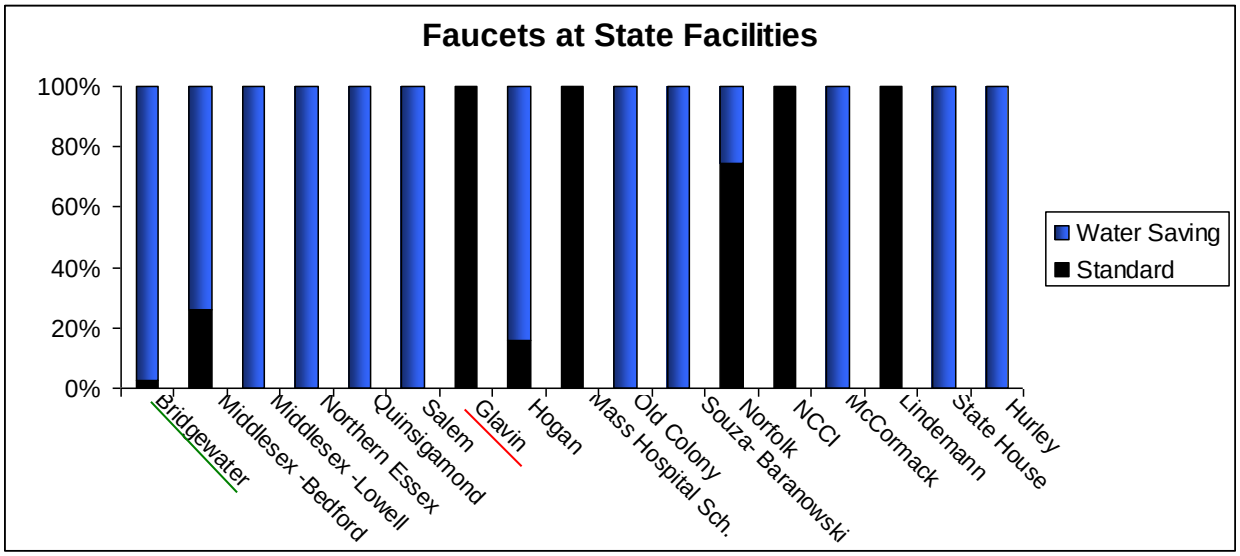

Figure 15. Prevalence of water saving faucets at Massachusetts State facilities.

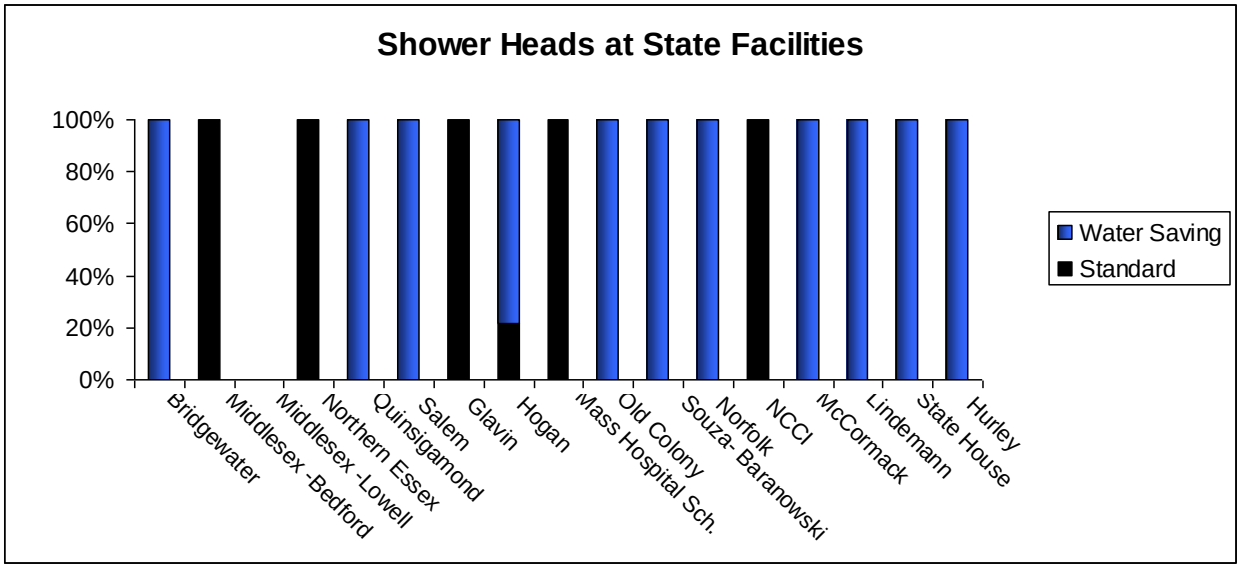

Figure 16. Prevalence of water saving shower heads at Massachusetts State facilities. Missing bars on the graph does not represent missing data, but that a particular facility does not have shower heads.

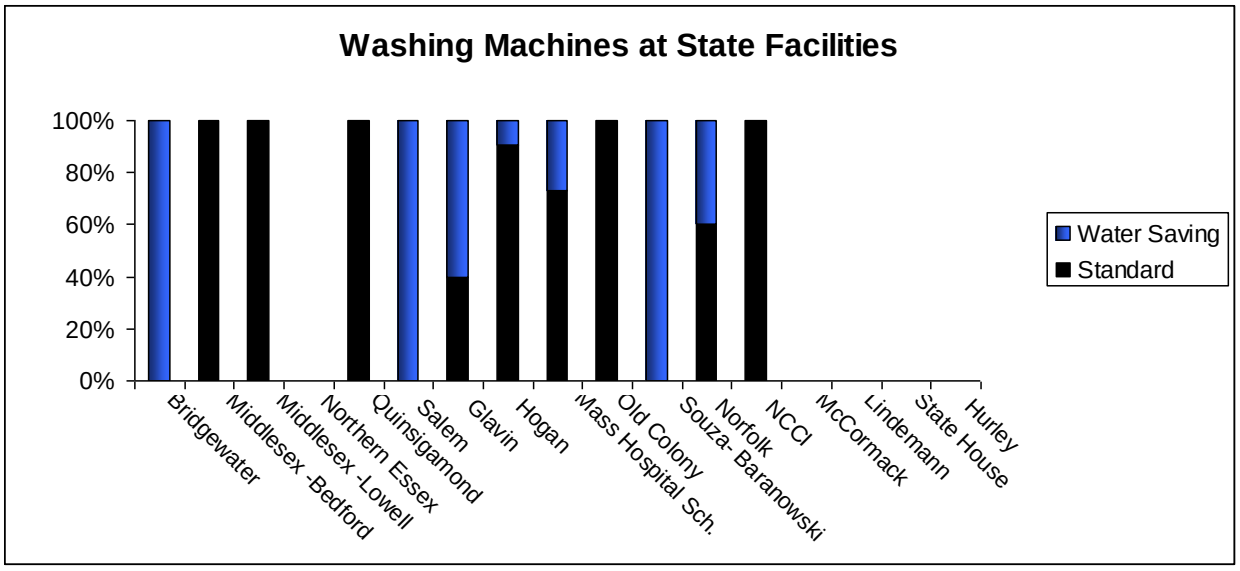

Figure 17. Prevalence of water saving washing machines at Massachusetts State facilities. Missing bars on the graph does not represent missing data, but that a particular facility does not have washing machines.

Water Conservation Practices

Most facilities use at least one simple outdoor water conservation practice, many facilities use at least two. The outdoor water conservation practices most used are watering between sunset and sunrise, using native or more drought resistant grasses and plants, and using mulch/peat moss to minimize water evaporation from around plant roots. The facility that stands out as completely lacking water conservation practices is UMass Amherst. Seeing that UMass Amherst is the largest water consumer of the facilities surveyed and uses a relatively large (8%) of total water use for outdoor purposes, the lack of simple, cost-free outdoor water conservation practices is unacceptable.

A somewhat surprising result of the Water Use and Conservation Survey is the lack of simple water conservation education efforts at facilities. Most facilities seem focused on realizing water conservation through infrastructure changes and are ignoring investment in low cost water conservation education programs.

Another significant finding of the Water Use and Conservation Survey is that 100% of participating facilities understand the importance of water conservation and express a sincere interest in enhancing water conservation at their facility. Those facilities that have not had major water conservation efforts highlight a lack of funding as the major hindrance.

Recommendations

The enthusiasm and understanding of the importance of water conservation expressed by the surveyed facility managers makes the prospect of enhanced water conservation at State facilities positive despite the practical challenges.

The Water Use and Conservation Survey generated important bits of quantitative data that can help prioritize further water conservation efforts. For example, it is clear that water conservation efforts should focus on reducing indoor water uses as these are the most significant. Furthermore, the focus should be on replacing standard/outdated water fixtures, with priority given to toilets and faucets as these ranked as “major” water users, followed by shower heads and washing

machines that ranked as “moderate” water users. While the most popular water saving devices may not achieve the greatest water savings, in selecting and promoting water saving fixtures important consideration should be given to user acceptance. Some facilities (as identified earlier) have a high potential to enhance water conservation. Particular and immediate attention should be paid to Umass Darmouth which ranks as a moderate water user in the survey group and perhaps ranks worst in terms of water conservation efforts. Not only does Umass Darmouth have a serious (8 million gallon per year / $250,000 per year) infiltration and inflow problem, but virtually all water fixtures on the campus are standard, non-water saving fixtures.

The Survey also highlighted important gaps in metering and leak detection practices (especially in water distribution systems) as well as a need for more and regular water audits. The combination of good metering, leak detection, and regular water audits provides an excellent mechanism to detect and fix water loss problems early as well as to understand a facility’s water use. Comprehensive metering, regular leak detection monitoring, and regular water audits are, therefore, essential to enhancing water conservation planning and outcomes and should be one of the priority areas. Particular attention should be given to creating a comprehensive metering system in large facilities as such a system would provide constant real time data on how much water is being used where, and, if designed well, will minimize the need to physically check water distribution pipes for leaks.
Also, as mentioned earlier, a prerequisite for a comprehensive water audit is a good metering system.

Another area for improvement is storm water re-use and rain water collection for outdoor water needs. As the results show, there is a very low prevalence of such efforts although the potential is great. Massachusetts receives enough rainfall such that a large percentage, if not all, outdoor watering needs can be meet though storm water re-use and rain water collection, especially if other well-known outdoor lawn and landscaping water conservation tips are utilized. Even if storm water is not re-used consumptively on-site facilities could help the overall water balance of their watershed by designing drainage structures that would allow storm water to run into areas where it can infiltrate on-site, in-shed.

In addition to indicating priority areas and areas with great potential for improvement, the process of the Water Use and Conservation Survey highlighted important practical roadblocks to furthering water conservation as well as different, less-used avenues to promote and facilitate water conservation at State facilities. The remainder of the recommendations section gives focus to these.

Breaking down the major road block – Address the lack of funding issue

There a several plausible options to help mend the lack of funding issue that is so prevalent among facilities sincerely wanting to enhance water conservation. Some options are more traditional and include varieties of State funding while other options are less traditional and include varieties of internal facility funding.

A) Expand DCAM Energy and Water Conservation funding or create an independent large EOEEA fund for water conservation

Most surveyed facilities that have achieved significant water conservation efforts have done so with State bond funding for bundled energy and water conservation projects administered through DCAM (Division of Capital Asset Management). While DCAM funding and project management has been extremely successful in the facilities that have gone through the process (e.g. Bridgewater State College), because there is very limited funds, because there is a long waiting period, and because the process becomes so involved, it is not a practical option for many facilities genuinely wanting to do water conservation. If the DCAM funding for bundled Energy and Water Conservation projects is going to continue being the main funding avenue for State facilities, the fund needs to be increased and the process streamlined. Another approach would be to create a new independent sizable EOEEA fund strictly for water conservation that would give large-scale funding for the identified priority areas: replacement of standard water fixtures, comprehensive metering, regular leak detection monitoring, regular water audits, and increased water re-use. There are certain advantages that come with a large fund and project approach such as enhanced water and cost savings and decreased payback time. The EOEEA fund would be managed in a similar fashion to the DCAM fund in which facilities are offered long-term, no-interest loans that are repaid in a fixed time using the savings realized from water conservation efforts.

B) Create a small EOEEA fund exclusively for water conservation priority areas identified

An alternative to creating a deep fund and encouraging large scale projects is creating a smaller fund to address the same priority areas. This fund would give small loans up to $20,000 for replacement of standard water fixtures, comprehensive metering, regular leak detection monitoring, regular water audits, and increased water re-use. With the small fund approach, facilities will be encouraged to use a phased approach to water conservation, beginning first with replacement of water fixtures (giving priority to the most consuming and most used sets of fixtures). An important part to the success of the small fund approach is contracting a State-funded plumber/s to handle all labor associated with the replacement of water fixtures. Conversations with facility managers identified labor as one of the major costs in changing water fixtures, and thus the lack of an on-staff plumber as a major hindrance to water fixture replacement.

C) Internal Resource Pool (Intra & Inter Facility)

Although funding to facility departments at State facilities is stressed and other considerations such as safety maintenance take priority over water conservation efforts, State facilities need not be totally dependent upon State funding to do water conservation. There is opportunity at facilities (especially colleges/universities) for intra and inter facility resource pooling to fund water conservation efforts.

Intra facility resource pooling (most applicable to colleges/universities)

Funds for water conservation can come from other sources at State colleges/universities besides the facilities department. For example, fiscal responsibility for standard water fixture replacements in dormitories can be shared by the residence life department. In addition, without necessarily increasing tuition or fees, colleges/universities can make water conservation a big deal on campus from the very beginning through messages in acceptance brochures and then solicit prospective students and parents for small gifts (e.g. $5) to go directly towards on-campus water conservation efforts.

Inter facility revolving fund for water conservation efforts (applicable to all facilities)

If individual facility funds are too limited to realize meaningful water conservation efforts, such facilities can team-up with other like facilities to create a revolving fund for water conservation efforts, in particular standard fixture replacement. For example, 3 facilities may form a revolving fund in which each facility contributes $1,000 each six months that is awarded in turn to the participating facilities to fund a water conservation project. This means that every six months one of the 3 facilities would receive $3000 for water conservation, the equivalent of a small loan. This approach would naturally necessitate a phased approach to water conservation efforts. The State can help facilities that “register” a revolving fund by providing funding to contract a plumber to handle all fixture replacement needs at the participating facilities.

Expanding the reach - Work closely with top level facility administrators in addition to sustainability coordinators and facility department managers

As already stressed, all sustainability coordinators and facility department managers that participated in the Water Use and Conservation Survey understand intimately the importance of water conservation, if at least from a cost savings perspective. As mentioned, however, the number one hindrance to enhanced water conservation efforts at State facilities is funding. Because sustainability coordinators and facility department managers are not in control of how much money is budgeted for facility maintenance, they have little control over the funding problem. For this reason, working with and enlisting the support of top level facility administrators that control or have some influence over how facility funding is spent is crucial to overcoming the funding barrier.

Materials geared towards enlisting the support of top level administrators should be created and may include videos or brochures about the importance of water conservation in the State, the duty of State facilities in setting an example, and the benefits of water conservation (presented through case studies of facilities such as Bridgewater State Community College and Salem State College). Case studies should include practical details such as the typical cost of water fixture replacement, regular leak detection monitoring, installing additional meters, etc.; and typical pay back times for water conservation efforts.

Encouraging the exchange of ideas – facilitate an informal and formal water conservation forum

Personal communication with several facility managers through the Survey process revealed a lot of practical knowledge and experience on water conservation looked up within some facility managers who have successfully done water conservation at their facility. At the same time, there are many facility managers passionate about enhancing water conservation at their facility and who could really benefit from the practical knowledge and experience of others. Facilitating a forum for the exchange of ideas and experiences on water conservation could create substantial positive externalities. An example where this has already begun through communication as a result of the Survey process is information exchange between facility managers at Bridgewater State College and UMass Dartmouth.

Bringing back water conservation education

The Water Use and Conservation Survey revealed a facility focus on water fixture replacement and other infrastructural approaches to water conservation, but a significant lack of active water conservation education programs. Education has proven to be a powerful tool in altering behavior in all areas, water usage not being an exception. In addition to traditional bathroom reminders to conserve water, there are a number of more novel approaches facilities could use.

The approach used by Bridgewater (a water conservation mascot and computer pop-up reminder to conserve water) is savvy and advisable. “Unofficial water bills,” a concept alluded to in the 2006 Water Conservation Standards, could also have a high impact. Quarterly “water bills” in facility common areas and attached to pay checks or tuition fees showing how much water is used and the associated cost for each facility/building/building cluster/dormitory/department would create a vivid relationship in users’ minds between their water use habits and the cumulative water and cost impacts of those habits.

An important element of water conservation education is starting from the very beginning. Facilities can make prospect students and employees aware of their water conservation policies in acceptance brochures/letters. By doing so, persons would enter the facility expecting water conservation to be a part of the facility life and likely be more open and responsive to water conservation education.